MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

EEL3086 –SWITCHGEAR AND PROTECTION

(LE)

01 MARCH 2017
09:00 A.M - 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 4 pages including cover page with 4 questions only.

2. Answer all questions. All questions carry equal marks of 25. The distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) What are the functions of protective relays? Define protected zone, primary protection and back up protection in power system. [8 marks]

(b) Give the consequences of short circuit. What are unit and non-unit protective system? [5 marks]

(c) Determine the time of operation of a 5A, inverse time-overcurrent relay having a current setting of 150% and a time multiplier setting of 0.4 when the circuit carries a fault current of 4000A. The relay is connected to a supply circuit through a 300/5 A current transformer. The relay characteristics are given in Table Q1c. [12 marks]

Table Q1c

PSM	2	4	6	8	10	12	14	16	18
Time, Sec	7.5	6	5	4.5	4	3	2.8	2.5	2

Question 2

(a) With the aid of diagram, explain why modern distance relays offer quadrilateral characteristics. [8 marks]

(b) With the aid of diagrams, explain the working of definite time overcurrent relays, and inverse time overcurrent relay. [10 marks]

(c) A circuit breaker (CB) was chosen for a short circuit test. The following readings were obtained on single frequency transient;

- Time to reach the peak re-striking voltage = 50 μ sec
- The peak re-striking voltage = 100 kV

Calculate

i) The average RRRV [4 marks]

ii) The frequency of oscillations. [3 marks]

Continued...

Question 3

(a) What is Arc in a circuit breaker and how it is established? [5 marks]

(b) A 21 kV-50 Hz, three-phase generator with earthed neutral has a reactance of 5 Ω/phase, and is connected to a bus-bar through a circuit breaker (CB). The distributed capacitance up to CB between phase and neutral is 0.01 μf. Determine;

i) The value of the peak re-striking voltage across the contacts of the CB in kV [5 marks]

ii) The frequency of oscillations in kHz [3 marks]

iii) The average rate of rise of re-striking voltage up to the first peak. [2 marks]

(c) Figure Q3c shows a typical excitation curve for IEEE class C current transformer (CT). A protection relay which is expected to operate for 5000 A at primary current is connected with the class C-CT ratio of 800/5. Secondary CT burden is 2.5 Ω. Will the CT saturate at this burden? Justify your answer with computation. [10 marks]

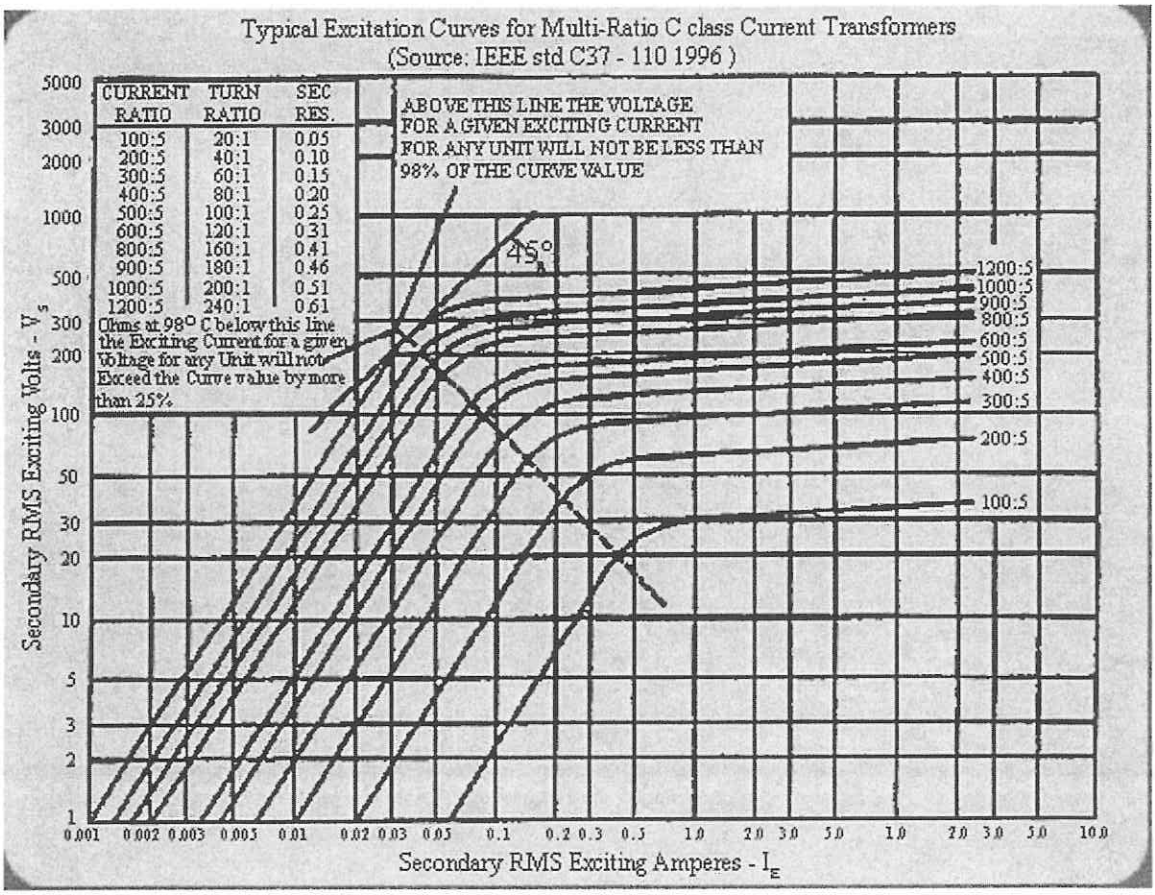
Typical Excitation Curves for Multi-Ratio C class Current Transformers
(Source: IEEE std C37 - 110 1996)
CURRENT RATIO | TURN RATIO | SEC RES.
100:5 | 20:1 | 0.05
200:5 | 40:1 | 0.10
300:5 | 60:1 | 0.15
400:5 | 80:1 | 0.20
500:5 | 100:1 | 0.25
600:5 | 120:1 | 0.31
800:5 | 160:1 | 0.41
900:5 | 180:1 | 0.46
1000:5 | 200:1 | 0.51
1200:5 | 240:1 | 0.61
Ohms at 98° C below this line the Exciting Current for a given Voltage for any Unit will not Exceed the Curve value by more than 25%
ABOVE THIS LINE THE VOLTAGE FOR A GIVEN EXCITING CURRENT FOR ANY UNIT WILL NOT BE LESS THAN 98% OF THE CURVE VALUE
45°
1200:5
1000:5
900:5
800:5
600:5
500:5
400:5
300:5
200:5
100:5
Secondary RMS Exciting Volts - V_s
5000
3000
2000
1000
500
300
200
100
50
30
20
10
5
3
2
1
0.001 0.002 0.003 0.005 0.01 0.02 0.03 0.05 0.1 0.2 0.3 0.5 1.0 2.0 3.0 5.0 1.0 2.0 3.0 5.0 10.0
Secondary RMS Exciting Amperes - I_E

Figure Q3c

Continued...

Question 4

(a) Explain the working of a digital protective relay? What are the advantages of a digital relay in comparison to a solid state relay? [6 marks]

(b) List at least ten alternator protection schemes. [5 marks]

(c) Draw the circuit diagram of a Differential protection scheme for a three-phase generator with CTs, relay, and its earthing resistance. [6 marks]

(d) An overcurrent relay performance has been monitored over a period of one year. It was found that the relay operated 15 times, out of which 12 were correct trips. If the relay failed to issue trip decision on 4 occasions, calculate percentage of dependability, security and reliability of the relay. [8 marks]

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